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Computer programs available in the Search Radar Branch at NRL applicable to evaluating surveillance radars are described. These programs represent work over the past decade. A brief description of each of the programs is given in the text with input data formats for many in the appendices. Listings and card decks reside in NRL Code 5331.

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CONTENTS

SOME COMPUTER PROGRAMS USEFUL IN EVALUATING SURVEILLANCE RADAR PERFORMANCE

Introduction

Computer programs are available in the Search Radar Branch at NRL which may be used to evaluate existing or proposed surveillance radars. Some of the programs represent work accomplished by L. V. Blake in the early 1970's. Several are the results of extensions and modifications of Blake's work after his retirement. Additionally there are other programs developed over the last decade which are useful in radar performance assessment. A brief description of these computer programs is given in this report. Input data formats are given in the Appendices. NRL Code 5331 has cognizance over the program listings and card decks for these programs. Some of these programs may also be available under other NRL codes.

ARRY8

This program plots the antenna radiation pattern for an eight-element linear array. Amplitudes and phases (voltage and radians) for each of the radiating elements are read in with a 10F8.2 input data format. The program computes, tabulates, and plots the antenna pattern points in decibels. The program is easily extended to larger arrays. In fact, an ARRY32 version for a low-sidelobe UHF array and an ARRY54 version which computes the elevation pattern of the AN/TPS-59 radar have been exercised.

ATTH2O

This program calculates the atmospheric attenuation for various water vapor densities at a selected radar frequency. It makes use of subroutine ALPHA from program RGCALC which computes absorption coefficients in decibels per nautical mile for altitudes above sea level from 0 to 100,000 feet.

Manuscript submitted May 26, 1982.

BEAMNO

This program counts the number of radiated beams necsessary for hemispheric coverage for a phase-mechanical scanned array antenna, given the array normal beamwidths and tilt angle. Inputs are: horizontal and vertical beamwidths, angle at which beam-broadening in elevation occurs, beam-broadening factor, number of pulses per beamwidth for search and/or track, and prf. Outputs which are tabulated for each elevation angle include: vertical and horizontal beamwidth, gain, number of beams at that elevation, and the total number of beams (additive) from the horizon to that elevation. Additional outputs are: time required to track a specified number of targets with the given number of pulses per tracking beam. It is assumed that the beam overlap is such that any target will lie within the 3 dB beamwidth of at least one beam. The calculations take into account the variation of beamwidth and gain with scan angle (in this case, elevation angle). To reconfigure the program for other array antennas (i.e., Dome or fixed-array) is a simple matter. Specific use of this computer program was made for a Small Craft Radar Design [1] in 1976.

DOBMNO

This program, which is similar to BEAMNO, counts the number of beams necessary for hemispheric coverage for a Dome antenna [2], assuming 1.5 to 2.0 degree beams at array normal (zenith) inputs and outputs are similar to those for BEAMNO. The variation of beamwidth and gain with scan angle is appropriate for the scan-tailored Dome. A 30 dB Taylor amplitude distribution is assumed.

BLOKAZ

This program was developed to estimate the blockage effects or the azimuth pattern for the AN/SPS-49 on certain frigates. The antenna was simulated by a 48-element linear array with an appropriate illumination function. The antenna pattern computation is similar to that for ARRY8. The shadow cast by vertical members of the ship's mast structure on the array elements was assumed to block all the energy for those elements. For elements between the shadowed ones, it was assumed that the radiated energy was reduced to 80% of that normally radiated. No reflection, reradiation, or diffraction effects were included.

BLOKEL

This program was developed to estimate the blockage effects on the elevation pattern for the AN/SPS-49 on certain frigates. The antenna was simulated by a 16-element linear array with an illumination function which was synthesized such that the resulting pattern closely approximated the recorded elevation pattern of the radar. For the calculation of the radiation pattern, the contribution from unshadowed elements of a vertical linear array were summed in the far field. That is, the pattern was that seen by an observer moving in the far field with certain portions of the array blocked. The actual pattern computation was then similar to that for ARRY8.

ELPBLK

This program computes antenna radiation patterns for a linear fixed-array (80 elements) with an elliptical stack in the near field. Inputs include amplitudes for each element, the scan angle from array normal, the dimensions of the stack, and distances from the stack to the array. The treatment considers only the two-dimensional (azimuth plane) case. Energy blockage by the stack, energy reflection, and diffraction are included. The program has been used to analyze performance of a fixed-array radar on certain proposed guided-missile ship configurations [3].

ELPLOT

This program plots the elevation pattern of a radar on a range-height chart. Decibel values are read in with a 10F8.2 format for 201 angles between 60° elevation and 0° elevation. This program was developed to be used with the outputs of SHAPMM for plotting range-height coverage charts for a mm-wave low-probability of intercept (LPI) radar and for the intercept equipment to detect such a radar.

LOBENV

This program is a modification of LOBPLT which plots the envelope of the interference lobing patterns for several radar elevation beams. The inputs are similar to those for LOBPLT. The input data format is given in Appendix A. The following parameters are entered for each radar beam: frequency, elevation beamwidth, elevation sidelobe level, tilt, and free-space range. At each elevation angle the greatest range in the lobing patterns for any of the radar beams is determined and plotted on the range-height chart.

LOBETR

This program is a version of LOBPLT modified to plot the interference pattern for the situation in which the transmit and receive antennas are separate and have different elevation beamwidths. The inputs for the transmit antenna are the same as LOBPLT. The following parameters are also entered for the receive antenna: antenna height, vertical beamwidth, sidelobe level, tilt, polarization, and shaping. The output is as described for LOBPLT. The input data format is given in Appendix B.

LOBMEB

This program is a version of LOBPLT which plots lobing patterns for multiple elevation beams. The inputs are similar to those for LOBPLT and LOBENV. The program is especially useful for showing elevation coverage for 3-D radars which have elevation beams generated by frequency change or phase shifters and for systems with multiple elevation beams. The input data format for this program is given in Appendix C.

LOBMUF

This program was developed to plot range-height-angle lobing charts for frequency-agile radars. It may be used to plot lobing charts for several radars or a single radar capable of radiating several frequencies [4]. The program, which builds on Blake's range-height charts and lobing plots assumes incoherent integration and a closed-form expression for a square-law detector.

In LOBMUF, the probability of detection, probability of false alarm, total number of pulses integrated, Swerling fluctuation case, and the number of radars or radar frequencies are specified on input data cards. In addition, for each radar or radar frequency, the free-space range, beamwidth, number of pulses at that frequency, sidelobe level, and a parameter FREF are required. FREF is set to zero if the free-space range was calculated at each frequency based on the number of pulses at that frequency; otherwise, FREF is the mid-band or average frequency and the free-space range corresponds to this reference frequency. Other inputs to the program are identical to those for LOBPLT. They concern the dimensions of the range-height chart, polarization radiated, antenna height and tilt, etc. The input data card formats for this program are given in Appendix D.

LOBPLT

LOBPLT [5] is a computer program for presenting the radar interference lobing phenomena on range-height-angle plots.

The output of LOBPLT is a plot of radar detection contours in the vertical plane with range and height as coordinates. Inputs to the program include the maximum x and y dimensions of the chart, the maximum range to be plotted on the chart, the maximum height to be plotted, the minimum elevation angle to be considered, and the maximum elevation angle. Additionally, the height of the radar antenna, radar frequency, radar vertical beamwidth, radar sidelobe level, and the tilt angle of the radar antenna are entered. Inputs also include the sea-wave height, radar free-space-range (RFS), radiated polarization, and a shaping factor. The shaping factor has to do with whether or not the vertical beam follows a cosecant-squared pattern. These vertical-plane coverage patterns are valuable in predicting regions in which targets will and will not be detected (peaks and nulls of the interference lobes). Input data format specifications for program LOBPLT are given in Appendix E.

LOBREP

This program is a version of LOBPLT which takes into account the actual elevation antenna pattern and the effects of tropospheric attenuation. The vertical-plane coverage patterns calculated in LOBPLT assume the vertical beam shape to be of the (sin x)/x form modified by the specified sidelobe level (a true (sin x)/x pattern has -13 dB sidelobes). The output of LOBREP is a single range-height chart with up to four vertical coverage plots:

a. A plot of the vertical coverage pattern without the effects of tropospheric attenuation or the interference lobing phenomenon,

b. A plot of the interference lobing pattern without tropospheric attenuation,

c. A plot of the vertical coverage pattern with the tropospheric attenuation effects, and

d. A plot of the interference lobing pattern with tropospheric attenuation.

Any one, or any combination, of the above plots may be chosen. Those inputs to LOBREP concerned with the range-height chart dimensions, polarization radiated, antenna height, tilt, plotting bounds, and free-space range are all identical to LOBPLT. Additional inputs include the number of antenna pattern points tabulated, the angular increment between antenna pattern points, the minimum angle for which antenna pattern points are tabulated, and a tabulation of the decibel values for the actual antenna pattern. The input data format specifications for program LOBREP are given in Appendix F. Some examples of the use of LOBREP may be found in Ref. [6]. A recent modification of this program allows the effects of sensitivity time control (STC) to be included by providing the range at which the STC start as an input.

LOWALT

This program calculates and generates a computer plot of signal-to-interference ratio as a function of range for a constant altitude target [7]. These plots are somewhat similar to signal strength-versus-range plots for constant altitude targets described below for program SIGPLT. The calculations in LOWALT include a free-space range computation (see RGCALC) and a computation of signal-to-clutter improvement factors achievable with various processing techniques in a variety of environments. In addition to the computer plot the program provides a listing of the radar and target parameters used as inputs and the calculated outputs including noise temperatures, signal-to-noise ratio (visibility factor), and radar range.

To examine the detection range of a target in the presence of clutter and/or jamming, a threshold is computed which is equal to the ratio of the total noise power (jamming plus noise) to the receiver noise power. Modifications have been made to the basic program to compute the effects of land and rain clutter and to calculate the improvement factors in signal-to-clutter ratio provided by MTI and doppler filtering if applicable. Many of the inputs to the program are the same as those for programs RGCALC and SIGPLT. Additional inputs include the type and range of a jammer, azimuth beamwidth, prf, compressed pulse length, rotation rate, clutter enhancement factors, clutter back-scattering coefficients, clutter velocity standard deviations, number of MTI cancelling pulses, and number of doppler filter sampling points. A complete input data format for LOWALT is given in Appendix G.

PATLST

This program computes a simple (sin x)/x type antenna pattern with a given beamwidth and sidelobe level. The program chooses the pattern with the least amount of energy at each azimuth angle over the frequency band given and plots these chosen pattern points on a decibel-versus-angle rectangular plot. The program also computes the median and RMS sidelobe levels in decibels, i.e., the energy outside the nulls of the mainbeam and within the angular region considered. The program is useful in determining the theoretical improvement possible in a frequency agile radar with the capability to choose the least noisy frequency channel within the bandwidth of the system.

PLTPAT

This program is similar to PATLST except that a single frequency (sin x)/x pattern is plotted. The median and RMS sidelobe levels outside the mainbeam and within a given angular region are computed.

REDERN

This program calculates the required detection range for missile engagement of a target. The computation is for various target speeds, system reaction times, and counter-missile speeds. A minimum engagement range of one nautical mile is assumed. Constant linear velocities for target and counter-missile are also assumed. The program provides a tabulation of required detection range for various missile speeds and reaction times.

RGCALC

The program [8] calculates the free-space range for any specified probability of detection, false-alarm probability, and Swerling fluctuation case. Noncoherent integration is assumed. The system noise temperature and two-way absorption through the troposphere are calculated. The signal-to-noise ratio (visibility factor) and tropospheric attenuation associated with each range calculation are listed as outputs. The inputs include transmitter power, pulse length, transmit and receive antenna gain, target cross section, frequency, several loss factors, receiver noise factor and the number of pulses integrated. A complete description of the program, the input format, and the output formats are given in Ref. [8]. Specifically, the program is a Fortran formulation of Eq. (12) of NRL Report 6930 [9], with pattern-propagation factors (F_t, F_r) assumed to be unity.

RGCMPD

This program is an offshoot of RGCALC. RGCMPD computes the free space range for a specified cumulative probability of detection P_c, false alarm probability, and Swerling fluctuation care. The program inputs are similar to RGCALC except that the cumulative rather than the single scan probability of detection is specified. The time between scans (date interval) and the target radial velocity are also entered. The detection range for 0 -dB signal-to-noise ratio is computed first. The range of the target for each radar scan period is then calculated and used to find the single-scan probability of detection, P_d. This process is repeated until the specified P_c is achieved by the relation:

$$P_c = 1 - \prod_{i=1}^{n} (1 - P_{di})$$

Outputs include single-scan probability of detection, signal-to-noise ratio, tropospheric attenuation, and free space range for each scan. Input data format for this program is given in Appendix H.

RGIMP

This program calculates the detection range in nautical miles available with scan-to-scan integration and plots this detection range versus the number of scans. Inputs include probability of detection (single scan), probability of false alarm (power of 10), Swerling case, number of pulses per dwell, maximum numbers of scans to be considered, target velocity, data interval in seconds (time between scans), maximum range for chart, and single-scan detection range. The program assumes constant radial velocity for an inbound target.

SCAN52

This program is an outgrowth of BEAMNO developed specifically for proposed elevation scanning modes for the AN/SPS-52 [10]. The outputs are tabulations of the various modes proposed giving the following parameters for each elevation beam: elevation angle, vertical beamwidth, gain, instrumented range, computed detection range, relative power transmitted, PRF, pulse length, dwell time, duty, frequency transmitted, and sequence number of the beam. Additionally, the total time for volume search, numbers of azimuth beam positions per rpm, overall average duty for transmitter, and total time used per azimuth dwell are computed and tabulated.

SHAPEL

The amplitude and phase distribution for a linear antenna array to achieve a shaped elevation pattern may be computed using this program. The method used consists of superimposing a series of uniform-amplitude, linear phase distributions across the aperture in such a way that the sum of the patterns adds up to the desired pattern. The required distribution is then found by adding up the individual uniform illumination [11]. Thus it is possible to synthesize a pattern which can be uniquely specified at 2m+1 points for an aperture which is m wavelengths in extent. The program has been used to obtain distribution for shaped beams at the lower radar frequencies (UHF and L-band). The pattern is shaped to follow a given altitude from the upper 3 dB point on the main lobe.

SHAPMM

This program is quite similar to SHAPEL in that it computes the distribution required for a given shaped elevation pattern. However, this program was developed for a millimeter-wave radar. At mm-wave frequencies, the tropospheric attenuation effects must be considered in order to assure coverage to a given altitude. For that purpose, the necessary subroutines have been excerpted from RGCALC.

SIGENV

This program is a modification of SIGPLT which plots the envelope of the interference lobes for several radar elevation beams. The input data format is given in Appendix I. As in LOBENV, certain parameters are entered for each radar beam. At each range the greatest signal level in the lobing patterns for any of the radar beams is computed and plotted. Unlike SIGPLT, this program incorporates the effect of the elevation beamwidth and sidelobe levels.

SIGMUF

This program was developed to plot signal-level versus range curves for frequency-agile radars. Like LOBMUF it may be used to plot charts for several radars or a single radar capable of radiating several frequencies in a dwell. The program builds on SIGPLT and has the same detection and integration assumptions as LOBMUF. The program also incorporates the effects of the elevation beamwidth and sidelobe levels (SIGPLT does not). The input data card formats for this program are given in Appendix J.

SIGPLT

The program [5] calculates and plots signal level in decibels as a function of range for a target of fixed height. It is intended primarily for presenting the interference lobing pattern for low-altitude targets. The radar horizon is first calculated. The x-axis is then established for a maximum range slightly beyond the horizon. The antenna pattern is not taken into account because for low-altitude targets, the significant radiation all comes from the same part of the beam; viz., that part directed toward the horizon. The signal-level plot is begun at the maximum range and is terminated when the range has decreased to a specified maximum value. Inputs to the program include the maximum x and y dimensions of the chart, heights of the radar antenna and the target, free-space range, elevation beamwidth, sea-wave height, and radiated polarization. The input data format specifications for this program are given in Appendix K.

SIGREP

This program is a version of SIGPLT which takes into account the actual elevation antenna pattern and the effects of tropospheric attenuation. The output of SIGREP is a chart with up to four curves of signal-level versus range:

a. A plot of signal level without the effects of tropospheric attenuation or the interference lobing phenomenon,

b. A plot of signal-level with the lobing effects but without tropospheric attenuation,

c. A plot of signal-level with tropospheric attenuation but without the lobing effects, and

d. A plot of signal-level showing both the lobing effects and the tropospheric attenuation.

Any one, or any combination, of the above plots may be chosen. In addition to the normal SIGPLT inputs, the program uses the number of antenna pattern points tabulated, the angular increment between antenna pattern points, the minimum angle for which antenna pattern points are tabulated, and a tabulation of the decibel values for the actual antenna pattern. The input data format specifications for program SIGREP are given in Appendix L. Some examples of the use of SIGREP may be found in Ref. [6].

SOJCAL

For the case in which the jammer is at a fixed location with respect to the radar (standoff jamming), the maximum detection range in nautical miles is given by [9]:

$$R_{max} = 129.2 \left[\frac{P_{t(kW)}\, \tau_{(\mu sec)}\, G_t G_r \sigma_{(sq\ m)} F_t^2 F_r^2}{f^2_{(MHz)} \left(T_s + \frac{P_{rj}}{k}\right) V_o C_B L} \right]^{1/4} \tag{1}$$

where

F_t = pattern propagation factor for transmitting-antenna-to-target path,

F_r = pattern propagation factor for target-to-receiving-antenna path

$P_{t(kW)}$ = radar transmit power in kilowatts

$\tau(\mu sec)$ = radar pulse length in microseconds

G_t = radar transmit antenna gain

G_r = radar receive antenna gain

$\sigma(sq\ m)$ = radar target cross section in square meters

$f_{(MHz)}$ = frequency in MHz

V_o = visibility factor

T_s = receiving system noise temperature

C_B = bandwidth correction factor

k = Boltzmann's constant (1.38×10^{-23} watt-sec/°K)

L = system loss factor

P_{rj} = received-jamming-signal power density (W/MHz) given by:

$$P_{rj} = 1.66 \times 10^{-10} \left[\frac{P_{tj}(W/MHz)\ G_j G_r F^2{}_j}{f^2{}_{(MHz)} R_j{}^2} \right] \qquad (2)$$

where

R_j = range to jammer in nautical miles

$P_{tj}(W/MHz)$ = jammer power in Watts per MHz

G_j = jammer antenna gain

F_j = pattern-propagation factor for jamming-signal propagation path

A computer program, SOJCAL, solves Equations (1) and (2). SOJCAL uses most of the same subroutines as RGCALC; only simple modifications in the main routine and two subroutines were required. Most of the input parameters are similar to those of RGCALC and the output format is the same. Among the assumptions made in developing this program are:

a. The pattern-propagation factor for the radar transmitter-to-target, F_t, and target-to-receiver, F_r, paths are assumed = 1,

b. The standoff jammer is assumed to be at zero-degrees elevation relative to the radar.

The input data format for program SOJCAL is given in Appendix M.

SSJCAL

If a radar target is carrying a jammer (self-screening), the maximum detection range, R_{max}, is given by [9]:

$$R_{max} = 4.817 \times 10^{-3} F_t \left[\frac{P_{t(kW)}\, \tau_{(\mu sec)}\, G_t\, \sigma_{(sq\ m)}}{P_{tj(W/MHz)}\, G_j\, V_o\, C_B\, L} \right]^{1/2} \quad (3)$$

where

F_t = pattern propagation factor for transmitting-antenna-to-target path,

$P_{t(kW)}$ = radar transmit power in kilowatts,

$\tau_{(\mu sec)}$ = radar pulse length in microseconds,

G_t = radar transmit antenna gain,

$\sigma_{(sq\ m)}$ = radar target cross section in square meters,

$P_{tj(W/MHz)}$ = jammer power in Watts per MHz,

G_j = jammer antenna gain,

V_o = visibility factor, or predection signal-to-noise ratio required for the specified probability of detection,

C_B = bandwidth correction factor (which accounts for the loss resulting from a mismatch between the pulse characteristics and the receiver filter transfer characteristic), and

L = system loss factor, equal to the product of several component loss factors. (Transmitting line loss, antenna-pattern scan loss, collapsing loss, signal-processing loss, array fill-time absorption loss, and the <u>one-way</u> tropospheric absorption loss.)

This equation assumes that the jammer noise power density is much larger than the receiver noise in the absence of jamming. Furthermore, the maximum range calculated by this equation must be less than half that calculated for the free-space range in the absence of jamming for the results to be considered valid.

Following the techniques used in generating the computer program RGCALC [8] which calculates the free-space range, a program has been developed which gives solutions to Equation (3) above. This program has been named SSJCAL for the self-screening jammer. SSJCAL uses most of the same subroutines as RGCALC: only simple modifications in the main routine and two subroutines were required. Most of the input parameters are similar to those of RGCALC and the output format is the same.

In addition to some of the parameters listed above, inputs to the program include the number of pulses, the probability of detection, the probability of false alarm, and the Swerling case number, all of which are used to calculate V_0 in the program. Inputs also include the target elevation angle and the radar frequency which are used to calculate tropospheric losses.

Among the other assumptions made in developing SSJCAL are:

1. The pattern-propagation factor for the radar transmitter-to-target F_t, path is assumed = 1.

2. "Average" solar and galactic noise levels are assumed.

The input data format for program SSJCAL is given in Appendix N.

STSINT

This program calculates the improvement factor available with scan-to-scan integration and plots this improvement factor versus range. The inputs are: probability of single-scan detection, probability of false alarm, Swerling case, number of pulses per dwell, maximum number of scans considered, target velocity, data interval, maximum range for chart, and maximum decibels improvement factor for chart. Like RGIMP, the program assumes constant radial velocity for an inbound target.

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APPENDIX A

Input Data Format for Program LOBENV (February 1982)

Program LOBENV will plot the envelope of n frequencies on a range-height plot.

Input Card Sequence

1. Blank Card

2. Label Card

3. Grid Parameters:

	FORMAT	COL.
a. XMAX	F6.0	1-6
b. YMAX	F6.0	7-12
c. RMAX	F6.0	13-18
d. HMAX	F8.0	19-26
e. AHFT	F4.0	27-30
f. WHFT	F6.0	31-36
g. IPOL	I1	38
h. ICSC	I1	40

4. NBEAM — I2 — 1-2

5. Radar parameters in F10.0 fields:

	FORMAT	COL.
a. FMHZ	F7.0	1-7
b. BWD	F6.0	8-13
c. SLDB	F5.0	14-18
d. TILT	F6.0	19-24
e. THMIN	F6.0	25-30
f. THMAX	F6.0	31-36
g. RFS	F6.0	37-42

Repeat Card 5 for NBEAM repetitions.

Multiple plots may be made by repeating card sequence starting with Input Card 2.

Definitions of Data Inputs

XMAX	=	Maximum X dimension of chart in inches
YMAX	=	Maximum Y dimension of chart in inches
RMAX	=	Maximum range of chart in nautical miles
HMAX	=	Maximum height of chart in feet
AHFT	=	Radar antenna height in feet above sea level
WHFT	=	Sea-wave height in feet
IPOL	=	1 for vertical, 2 for horizontal polarization
ICSC	=	0 for pencil beam, 1 for cosecant-squared beam
NBEAM	=	Number of frequencies
FMHZ	=	Frequency in Megahertz
BWD	=	Vertical beamwidth in degrees
SLDB	=	First elevation sidelobe level in dB
TILT	=	Tilt of radar antenna, in degrees relative to horizontal
THMIN	=	Minimum elevation angle, in degrees, to which coverage is desired
THMAX	=	Maximum elevation angle, in degrees, to which coverage is desired
RFS	=	Free-space range in nautical miles

APPENDIX B
Input Data Format for Program LOBETR
(Jan 1977)
(* Denotes Integer Field)

DATA CARD NUMBER 1

Data Identifier	Data Format Specification	Data Field Width From Column	To Column
Error	F5.0	1	5
IADD	I1	10	-

Data Card Numbers 3, 6, 7, etc.
Transmit Characteristics and Chart Parameters

Data Identifier	Data Format Specification	Data Field Width From Column	To Column
XMAX	F6.0	1	6
YMAX	F6.0	7	12
RMAX	F6.0	13	18
HMAX	F8.0	19	26
AHFT	F4.0	27	30
FMHZ	F6.0	31	36
BWD	F6.0	37	42
SLDB	F6.0	43	48
WHFT	F6.0	49	54
TILT	F6.0	55	60
THMIN	F4.0	61	64
THMAX	F4.0	65	68
RFS	F6.0	69	74
IPOL	I1	76*	--
ICSC	I1	78*	--

Data Card Numbers 2, 5, 8, etc. -- Chart Legend
Use all 80 columns of card -- insert blank if no legend is desired

Data Cards 4, 7, 10, etc. — Receive Characteristics

Data Identifier	Data Format Specification	Data Field Width From Column	To Column
AHFTR	F4.0	1	4
BWDR	F6.0	5	10
SLDBR	F6.0	11	16
TILT2R	F6.0	17	22
IPOLR	I1	24*	--
ICSCR	I1	26*	--

EXPLANATION OF DATA INPUTS FOR PROGRAM LOBETR

ERROR = Deviation tolerance from straight line--blank if .001 is satisfactory

IADD = 1 only if adding plots to tape, otherwise leave blank

XMAX = Maximum X dimension of chart in inches

YMAX = Maximum Y dimension of chart in inches

RMAX = Maximum range of chart in nautical miles

HMAX = Maximum height of chart in feet

AHFT = Transmit antenna height in feet above sea level

FMHz = Radar frequency in megahertz

BWD = Transmit vertical beamwidth in degrees

SLDB = Transmit sidelobe level in decibels

WHFT = Sea-wave height in feet

TILT = Tilt of transmit antenna, in degrees, with respect to horizontal

THMIN = Minimum elevation angle, in degrees, to which coverage is desired

THMAX = Maximum elevation angle, in degrees, to which coverage is desired

RFS = Maximum radar free-space range in nautical miles

IPOL = 1 if transmit antenna is vertically polarized, 2 if horizontally

ICSC = 1 if transmit beam follows cosecant-squared pattern, blank otherwise

AHFTR = Receive antenna height in feet above sea level

BWDR = Receive vertical beamwidth in degrees

LSDBR = Receive sidelobe level in decibels

TILT2R = Tilt of receive antenna

IPOLR = 1 if receive antenna is vertically polarized, 2 if horizontally

ICSC = 1 if receive beam follows cosecant-squared pattern, blank otherwise

Note:

HMAX must be chosen in accordance with the following table:

HMAX (ft)	Choose HMAX in even multiples of (ft)
0 - 30	1
30 - 300	10
300 - 3K	100
3K - 30K	1000
30K - 300K	10K
300K - 3000K	100K
3000K - 9999.9K	1000K

RMAX must be chosen in accordance with:

RMAX (n.mi.)	Choose RMAX in even multiples of (n.mi.):
0 - 100	5
100 - 300	10
>300	25

APPENDIX C

Input Data Format for Program LOBMEB
(May 1980)
(* Denotes Integer Field)

DATA CARD NUMBER 1

Data Identifier	Data Format Specification	Data Field Width From Column	To Column
ERROR	F5.0	1	5

Data Card Number 2 -- Chart Legend use all 80 columns of card - insert blank if no legend is desired

DATA CARD NUMBER 3

Data Identifier	Data Format Specification	Data Field Width From Column	To Column
XMAX	F6.0	1	6
YMAX	F6.0	7	12
RMAX	F6.0	13	18
HMAX	F8.0	19	26
AHFT	F4.0	27	30
WHFT	F6.0	31	36
IPOL	I1	38*	--
ICSC	I1	40*	--

Data Cards Numbers 4, 5, 6, ... (One Per Beam)

Data Identifier	Data Format Specification	Data Field Width	
		From Column	To Column
FMHZ	F7.0	1	7
BWD	F6.0	8	13
SLDB	F5.0	14	18
TILT	F6.0	19	24
THMIN	F6.0	25	30
THMAX	F6.0	31	36
RES	F6.0	37	42

EXPLANATION OF DATA INPUTS FOR PROGRAM LOBMEB

ERROR =	Deviation tolerance from straight line -- blank if .001 is satisfactory
XMAX =	Maximum X dimension of chart in inches
YMAX =	Maximum Y dimension of chart in inches
RMAX =	Maximum range of chart in nautical miles
HMAX =	Maximum height of chart in feet
AHFT =	Radar antenna height in feet above sea level
WHFT =	Sea-wave height in feet
IPOL =	1 ft radar antenna is vertically polarized, 2 if horizontally
ICSC =	1 if vertical beam follows cosecant-squared pattern, blank otherwise
FMHZ =	Radar frequency in megahertz for each beam
BWD =	Radar vertical beamwidth in degrees
SLDB =	Radar sidelobe level in decibels
TILT =	Tilt of radar beam, in degrees, with respect to horizontal
THMIN =	Minimum elevation angle, in degrees, nominally 0° or the tilt angle less two times BWD
THMAX =	Maximum elevation angle, in degrees, at least equal to the tilt angle plus two times BWD
RFS =	Maximum radar free-space range in nautical miles for each beam

APPENDIX D

Input Data Format for Program LOBMUF (January 1977)

INPUT CARD SEQUENCE

		COL.
1.	ANTHGT in F10.0 field	1-10
2.	Label Card	
3.	Grid parameters in F10.0 fields:	
	a. XMAX	1-10
	b. YMAX	11-10
	c. RMAX	21-30
	d. HMAX	31-40
	e. THMIN	41-50
	f. THMAX	51-60
	g. WHFT	61-70
	h. RDR	71-80

Except for RDR, the parameter definitions are found in NRL Report 7098. RDR is the number of radars for which an envelope is to be plotted.

4. Common parameters in F10.0 fields:

a.	PDT	1-10
b.	PFA	11-20
c.	PULS (total number of pulses)	21-30
d.	CASE	31-40
e.	AHFT	41-50
f.	TILT	51-60
g.	POL	61-70
h.	CSC	71-80

5. Radar parameters in F10.0 fields:

a.	RFS	1-10
b.	FMHZ	11-20
c.	BWD	21-30
d.	SLDB	31-40
e.	PULNUM (number of pulses at FMHZ)	41-50
f.	FREF	51-60

Repeat Card 5 for RDR repetitions.

Again, most parameters are defined in NRL Report 7098. CSC is for pencil or cosecant squared antenna pattern:

CSC = 0. Pencil beam

CSC = 1. Cosecant squared beam

For reference, POL is polarization as follows:

POL	=	1.	Vertical
POL	=	2.	Horizontal

FREF = Frequency used to calculate RFS if RFS was calculated for the total number of pulses (PULS).

FREF = 0, if RFS was calculated at each frequency using PULNUM.

SLDB is the first elevation sidelobe level relative to the main lobe.

PDT is probability of detection.

PULS is total number of pulses.

CASE is Swerling case number.

PULNUM is number of pulses at specific frequency.

After Cards 1-5, the sequence can be repeated as many times as desired, starting with Card 2.

A note of caution: The elevation plot angle increment is determined by

$$\frac{THMAX - THMIN}{2000}$$

The value has proven adequate for S-band radars where 10° and 0° were the values for THMAX and THMIN. It is recommended that an envelope for a single radar (RDR = 1) be run when there is doubt that this angle increment is small enough.

Note:

HMAX must be chosen in accordance with the following table:

HMAX (ft)	Choose HMAX in Even Multiples of (ft)
0 - 30	1
30 - 300	10
300 - 3K	100
3K - 30K	1000
30K - 300K	10K
300K - 3000K	100K
3000K - 9999.9K	1000K

RMAX must be chosen in accordance with:

RMAX (n.mi.)	Choose RMAX in Even Multiples of (n.mi.)
0 - 100	5
100 - 300	10
>300	25

APPENDIX E

Input Data Format for Program LOBPLT
(January 1977)
(* Denotes Integer Field)

DATA CARD NUMBER 1

Data Identifier	Data Format Specification	Data Field Width From Column	To Column
Error	F5.0	1	5
IADD	I1	10	-

Data Card Numbers 3, 5, 7, etc.

Data Identifier	Data Format Specification	Data Field Width From Column	To Column
XMAX	F6.0	1	6
YMAX	F6.0	7	12
RMAX	F6.0	13	18
HMAX	F8.0	19	26
AHFT	F4.0	27	30
FMHZ	F6.0	31	36
BWD	F6.0	37	42
SLDB	F6.0	43	48
WHFT	F6.0	49	54
TILT	F6.0	55	60
THMIN	F4.0	61	64
THMAX	F4.0	65	68
RFS	F6.0	69	74
IPOL	I1	76*	-
ICSC	I1	78*	-

Data Card Numbers 2, 4, 6, etc. — Chart Legend
Use all 80 columns of card — insert blank if no legend is desired

EXPLANATION OF DATA INPUTS FOR PROGRAM LOBPLT

ERROR	=	Deviation tolerance from straight line--blank if .001 is satisfactory
IADD	=	1 only if adding plots to tape, otherwise leave blank
XMAX	=	Maximum X dimension of chart in inches
YMAX	=	Maximum Y dimension of chart in inches
RMAX	=	Maximum range of chart in nautical miles
HMAX	=	Maximum height of chart in feet
AHFT	=	Transmit antenna height in feet above sea level
FMHz	=	Radar frequency in megahertz
BWD	=	Transmit vertical beamwidth in degrees
SLDB	=	Transmit sidelobe level in decibels
WHFT	=	Sea-wave height in feet
TILT	=	Tilt of radar antenna, in degrees, with respect to horizontal
THMIN	=	Minimum elevation angle, in degrees, to which coverage is desired
THMAX	=	Maximum elevation angle, in degrees, to which coverage is desired
RFS	=	Maximum radar free-space range in nautical miles
IPOL	=	1 if radar antenna is vertically polarized, 2 if horizontally
ICSC	=	1 if transmit beam follows cosecant-squared pattern, blank otherwise

Note:

HMAX must be chosen in accordance with the following table:

HMAX (ft)	Choose HMAX in even multiples of (ft)
0 - 30	1
30 - 300	10
300 - 3K	100
3K - 30K	1000
30K - 300K	10K
300K - 3000K	100K
3000K - 9999.9K	1000K

RMAX must be chosen in accordance with:

RMAX (n.mi.)	Choose RMAX in even multiples of (n.mi.):
0 - 100	5
100 - 300	10
>300	25

APPENDIX F

Input Data Format for Program LOBREP
(February 1982)
(* Denotes Integer Field)

DATA CARD NUMBER 1

Data Identifier	Data Format Specification	Data Field Width From Column	Data Field Width To Column
Error	F5.0	1	5
IADD	I1	10	--
IA	I1	20	--
IB	I1	30	--
IC	I1	40	--
ID	I1	50	--

Data Card Numbers 2, N+1,... -- Chart Legend
Use all 80 columns of card -- insert blank if no legend is desired

Data Card Number 3, N+2,...

Data Identifier	Data Format Specification	Data Field Width From Column	To Column
XMAX	F6.0	1	6
YMAX	F6.0	7	12
RMAX	F6.0	13	18
HMAX	F8.0	19	26
AHFT	F4.0	27	30
FMHZ	F6.0	31	36
NNUM	I3	37	39
AINC	F6.4	40	45
WHFT	F6.2	46	51
AMIN	F6.2	52	57
THMIN	F4.0	58	61
THMAX	F4.0	62	65
RFS	F6.0	66	71
IPOL	I1	73*	--
RSTC	F6.1	75	80

Data Card Number 4 ... N

Format for data read in is 16F5.1 in dB values for antenna pattern. Use negative dB values for sidelobes known to be 180° out of phase with main beam. DB values begin on Data Card Number 4.

EXPLANATION OF DATA INPUTS FOR PROGRAM LOBREP

ERROR = Deviation tolerance from straight line--blank if .001 is satisfactory

IADD = 1 only if adding plots to tape, otherwise leave blank

IA = 1 if plot without lobes or attenuation is desired, 0 otherwise

IB = 1 if plot without lobes with attenuation is desired, 0 otherwise

IC = 1 if plot with lobes without attenuation is desired, 0 otherwise

ID = 1 if plot with lobes with attenuation is desired, 0 otherwise

XMAX = Maximum X dimension of chart in inches

YMAX = Maximum Y dimension of chart in inches

RMAX = Maximum range of chart in nautical miles

HMAX = Maximum height of chart in feet

AHFT = Radar antenna height in feet above sea level

FMHz = Radar frequency in megahertz

NNUM = Number of antenna pattern points tabulated

AINC = Angular increment between antenna pattern points

WHFT = Sea-wave height in feet

AMIN = Minimum angle for which antenna pattern points are tabulated

THMIN = Minimum elevation angle, in degrees, to which coverage is desired

THMAX = Maximum elevation angle, in degrees, to which coverage is desired

RFS = Maximum radar free-space range in nautical miles

IPOL = 1 if radar antenna is vertically polarized, 2 if horizontally

RSTC = Range at which STC starts, use 0. if no STC

Note:

HMAX must be chosen in accordance with the following table:

HMAX (ft)	Choose HMAX in even multiples of (ft)
0 - 30	1
30 - 300	10
300 - 3K	100
3K - 30K	1000
30K - 300K	10K
300K - 3000K	100K
3000K - 9999.9K	1000K

RMAX must be chosen in accordance with:

RMAX (n.mi.)	Choose RMAX in even multiples of (n.mi.):
0 - 100	5
100 - 300	10
>300	25

APPENDIX G

Input Data Format for Program LOWALT (March 1979)

Card Number 1
COL 1-64
NAME - Name or description of radar (limit to 64 characters).
COL 65-66 INC - Number of characters in radar name.

****

Card Number 2
COL 1-10
PT - Pulse Power, kW.
COL 11-20
TAU - Pulse length, microsec.
COL 21-30
GT - Transmit antenna gain, dB.
COL 31-40
GR - Receive antenna gain, dB.
COL 41-50
SIG - Target cross section, sq. m.
COL 51-60
FM - Frequency, MHz.
COL 61-70
ALA - Antenna ohmic loss, dB.
COL 71-80
ALR - Receive transmission line loss, dB.

****

Card Number 3
COL 1-10
ALT - Transmit transmission line loss, dB.
COL 11-20
ALP - Scanning antenna pattern loss, dB.
COL 21-30
ALX - Miscellaneous loss, dB.
COL 31-40
CB - Bandwidth correction factor, dB.
COL 41-50
ANF - Receiver noise factor (figure), dB.
COL 51-60
EN - Number of pulses integrated.
COL 61-70
PD - Probability of detection.
COL 71-80
FA - Probability of false alarm (clear) - positive exponent ten (e.g., PFA=10.**(-6), FA=6).

****

Card Number 4

COL 1-10
FAJ - Probability of false alarm (jamming)
COL 11-20
EL - Target elevation angle, degrees
COL 21-30
BWD - Vertical beamwidth, degrees
COL 31-40
TILT - Tilt angle, degrees
COL 41-50
SLDB - Sidelobe level (vertical), dB
COL 51-60
ERP1 - Effective radiated power S. S. JAM, w/MHz
COL 61-70
RJSO - Stand-off jammer range, n.mi.
COL 71-80
ERP2 - Effective radiated power S. O. JAM, w/MHz

****

Card Number 5

COL 1-10
FJ2 - Sidelobe level at jammer azimuth, dB
COL 11-20
WB - Bandwidth ratio, W/B, for Dickie-fix (must be non-zero)
COL 21-30
H1 - Antenna height, feet
COL 31-40
RMIN - Minimum range to be plotted, n.mi. (If RMIN=0., then it is set to 1/100 of RMAX in FRPLOT)
COL 41-50
EN1 - For collapsing loss, number of pulses containing signal return
COL 51-60
WHFT - Sea-wave height, feet.
COL 61-70
THETA- Azimuth beam in degrees
COL 71-80
PRF - Radar PRF (Pulse Repetition Frequency, Hz)

****

Card Number 6

COL 1-10
TAUC - Compressed pulse width
COL 11-20
H2 - Target height, feet
COL 21-30
SEFAC- Weather clutter (chaff) enhancement factor due to multiple path propagation

COL 31-40

DOFDB- Doppler filter designed sidelobe level

COL 41-50

RPM - Antenna scan rate revolutions per minute (set to 0 if doppler spread due to antenna scanning is included in clutter velocity deviation inputs)

****

Card Number 7

COL 1-10

GCDB - Ground clutter back scattering coefficient in dB

COL 11-20

SCDB - Sea clutter back scattering coefficient in dB

COL 21-30

WCDB - Weather clutter back scattering coefficient in dB. If GCDB, SCDB, or WCDB are set to zero, the corresponding clutter is assumed to be absent. If SCDB is set to be negative - back scattering coefficient will be calculated by built-in program.

COL 31-40

VGSD - Ground clutter velocity standard deviation in knots

COL 41-50

VSSD - Sea clutter velocity standard deviation in knots

COL 51-60

VWSD - Weather clutter velocity standard deviation in knots. If VWSD is set to be negative, velocity will be calculated by built-in program.

COL 61-70

VMD - The relative mean velocity between two types of clutter

COL 71-80

RIEL - Limit of MTI improvement factor, dB

****

Card Number 8

ALL DATA IS IN I5 FORMAT

COL 1-5

KA - 0 Non-fluctuating target
1-4 Swerling case I-IV
5 All of above (do not use with jamming)
6 Calculates range for given S/N (replace PD)
7 Same as 6 for two S/N (replace PD and PFA)

COL 6-10

ICSC - Vertical pattern flag
0 - (Sin X)/X
1 - CSC2

```
COL 11-15
      ID    -   Flag for fixes
                     0 - no fixes
                     1 - Dicke fix
                     2 - LOG-FTC
                     3 - Both
COL 16-20
      IPOL -   Polarization, 1 - vertical
COL 21-25
      NMTI -   Number of cancelling pulses, if NMTI=0, no MTI
COL 26-30
      INT   -   If INT .LT.0 assume correlation losses
                If INT .EQ.0 assume no correlation loss
                If INT .GT.0 assume INT pulses are integrated with no
                  correlation loss
COL 31-35
      NDOP -   No of doppler filter sampling points
                If NDOP=0, no doppler filter
COL 36-40
      NKD   -   The index of the doppler filter for output

**********************************************************************
```

APPENDIX H

Input Data Format for Program RGCMPD

Data Cards 1, 3, 5, etc.

Radar name or description
Use all 80 columns of card
Insert blank card if no legend is desired

Data Cards 2, 4, 6, etc.

Data Item	Format Specification	Card Columns
Transmitter Power, kW	F6.0	1-6
Pulse Length, μsec	F6.0	7-12
Transmit Antenna Gain, dB	F4.0	13-16
Receive Antenna Gain, dB	F4.0	17-20
Target Cross Section m^2	F6.0	21-26
Frequency, MHz	F6.0	27-32
Antenna Ohmic Loss, dB	F4.0	33-36
Receiving Line Loss, dB	F4.0	37-40
Transmit Line Loss, dB	F4.0	41-44
Antenna Pattern Scan Loss, dB	F4.0	45-48
Miscellaneous Loss, dB	F4.0	49-52
Time Between Scans, sec.	F4.0	53-56
Receiver Noise Factor, dB	F4.0	57-60
Number of Pulses	I5	61-65
Cumulative Probability of Detection	F4.0	66-69
False Alarm Exponent	F4.0	70-73
Swerling Fluctuation Case	I1	74
Target Velocity, n.mi. per hr.	F6.0	75-80

APPENDIX I

Input Data Format for Program SIGENV
February 1982

Program SIGENV will plot the signal level envelope of n frequencies for a constant-altitude target as a function of range.

Input Card Sequence

1. Blank Card

2. Label Card

3. Grid Parameters:

	FORMAT	COL.
a. XMAX	F10.0	1-10
b. YMAX	F10.0	11-20
c. H1	F10.0	21-30
d. H2	F10.0	31-40
e. WHFT	F10.0	41-50
f. RMIN	F10.0	51-60
g. IPOL	I1	61
h. JNUM	I2	71-72

4. Radar Parameters in F10.0 Format

a. TILT	1-10
b. CSC	11-20

5. Radar Parameters in F10.0 Format

a. RANGE	1-10
b. FREQ	11-20
c. BEAM	21-30
d. SDLOB	31-40

Repeat Card 5 for JNUM repetitions.

Multiple plots may be made by repeating card sequence starting with Input Card 2.

DEFINITION OF DATA INPUTS

XMAX	=	Maximum X dimension of chart in inches
YMAX	=	Maximum Y dimension of chart in inches
H1	=	Radar antenna height in feet above sea level
H2	=	Target height in feet above sea level
WHFT	=	Sea-wave height in feet
RMIN	=	Minimum range to which signal level will be plotted
IPOL	=	1 for vertical, 2 for horizontal polarization
JNUM	=	Number of frequencies
TILT	=	Tilt of radar antenna, in degrees, relative to horizontal
CSC	=	0 for pencil beam, 1 for cosecant squared beam
RANGE	=	Free-space range in nautical miles
FREQ	=	Frequency in megahertz
BEAM	=	Vertical beamwidth in degrees
SDLOB	=	First elevation sidelobe level in dB

APPENDIX J

Input Data Format for Program SIGMUF
November 1980

Input Card Sequence

		COL.
1. Label Card		1-80
2. Grid and common parameters in F10.0 fields:		
	a. XMAX	1-10
	b. YMAX	11-20
	c. RMAX	21-30
	d. HMAX	31-40
	e. WHFT	41-50
	f. RMIN	51-60
	g. POL	61-70
	h. RDR	71-80
3. Common parameters in F10.0 fields:		
	a. TILT	1-10
	b. CSC	11-20
4. Common parameters in F10.0 fields:		
	a. PDT	1-10
	b. PFA	11-20
	c. PULS	21-30
	d. CASE	31-40
5. Frequency-dependent parameters in F10.0 fields:		
	a. RFS	1-10
	b. FMHz	11-20
	c. BWD	21-30
	d. SLDB	31-40
	e. PULNUM (number of pulses at FMHZ)	41-50
	f. FREF	51-60

Repeat Card 5 for number of frequencies (RDR).

Most parameters are defined in NRL Report 7098. CSC is for pencil or cosecant squared antenna pattern:

CSC = 0.	pencil beam
CSC = 1.	cosecant squared beam

For reference, POL is polarization as follows:

POL = 1.	vertical
POL = 2.	horizontal

FREF = Frequency used to calculate RFS if RFS was calculated for the total number of pulses (PULS).

FREF = 0, if RFS was calculated at each frequency using PULNM.

SLDB is the first elevation sidelobe level relative to the mainlobe.

PDT is probability of detection.

PULS is total number of pulses.

CASE is Swerling case number.

PULNUM is number of pulses at specific frequency.

After Cards 1-5, the sequence can be repeated as many times as desired, starting with Card 2.

APPENDIX K

Input Data Format for Program SIGPLT
(January 1977)
(* Denotes Integer Field)

Data Card Number 1

Data Identifier	Data Format Specification	Data Field Width From Column	To Column
IADD	I1	1	---

Data Card Numbers 3, 5, 7, etc.

Data Identifier	Data Format Specification	Data Field Width From Column	To Column
XMAX	F6.0	1	6
YMAX	F6.0	7	12
H1	F6.0	13	18
H2	F6.0	19	24
RFS	F6.0	25	30
BWD	F6.0	31	36
WHFT	F6.0	37	42
FMHZ	F10.2	43	52
RMIN	F10.4	53	62
IPOL	I3	63	65

Data Card Numbers 2, 4, 6, etc. -- Chart Legend
Use all 80 columns of card -- insert blank if no legend is desired

EXPLANATION OF DATA INPUTS FOR PROGRAM SIGPLT

IADD	=	1 only if adding plots to tape, otherwise leave blank
XMAX	=	Maximum X dimension of chart in inches
YMAX	=	Maximum Y dimension of chart in inches
H1	=	Radar antenna height in feet above sea level
H2	=	Radar target height in feet above sea level
FHMZ	=	Radar frequency in megahertz
RFS	=	Maximum radar free-space range in nautical miles
BWD	=	Radar vertical beamwidth in degrees
WHFT	=	Sea-wave height in feet
IPOL	=	1 if radar antenna is vertically polarized, 2 if horizontally
RMIN	=	Minimum range to which signal level will be plotted

APPENDIX L

Input Data Format for Program SIGREP
(February 1977)
(* Denotes Integer Field)

Data Card Number 1

Data Identifier	Data Format Specification	Data Field Width From Column	To Column
IADD	I1	1	--
IA	I1	11	--
IB	I1	21	--
IC	I1	31	--
ID	I1	41	--

Data Card Numbers 2, 4, 6, etc. -- Chart Legend
Use all 80 columns of card - insert blank if no legend is desired

Data Card Numbers 3, 5, 7, etc.

Data Identifier	Data Format Specification	Data Field Width From Column	To Column
XMAX	F6.1	1	6
YMAX	F6.1	7	12
H1	F6.1	13	18
H2	F6.1	19	24
RFS	F6.1	25	30
WHFT	F6.1	31	36
AINC	F6.4	37	42
AMIN	F6.2	43	48
FMHZ	F10.2	49	58
NNUM	I3	59	61
IPOL	I1	62	--

EXPLANATION OF DATA INPUTS FOR PROGRAM SIGREP

IADD = 1 only if adding plots to tape, otherwise leave blank

IA = 1 if plot without lobes or attenuation is desired, 0 otherwise

IB = 1 if plot without lobes with attenuation is desired, 0 otherwise

IC = 1 if plot with lobes without attenuation is desired, 0 otherwise

ID = 1 if plot with lobes with attenuation is desired, 0 otherwise

XMAX = Maximum X dimension of chart in inches

YMAX = Maximum Y dimension of chart in inches

H1 = Radar antenna height in feet above sea level

H2 = Radar target height in feet above sea level

RFS = Maximum radar free-space range in nautical miles

WHFT = Sea wave height in feet

AINC = Angular increment between antenna pattern points

AMIN = Minimum angle for which antenna pattern points are tabulated

FMHZ = Radar frequency in megahertz

IPOL = 1 if radar antenna is vertically polarized, 2 if horizontally

NNUM = Number of antenna pattern points tabulated

APPENDIX M

Input Data Format for Program SOJCAL (June 1979)

Data Card Numbers 1, 4, 7, ... - Radar Names or Description
Use all 80 columns of card if necessary

Data Card Numbers 2, 5, 8, ...

Data Identifier	Data Format Specification	Data Field Width	
		From Column	To Column
PT	F6.0	1	6
TAU	F6.0	7	12
GT	F4.0	13	16
GR	F4.0	17	20
SIG	F6.0	21	26
FMHZ	F6.0	27	32
LA	F4.0	33	36
LR	F4.0	37	40
LT	F4.0	41	44
LP	F4.0	45	48
LX	F4.0	49	52
CB	F4.0	53	56
NF	F4.0	57	60
NP	I5	61	65
PD	F4.0	66	69
FA	F4.0	70	73
KASE	I1	74*	--
ELEV	F4.0	75	78
NOISE	I2	79	80

*Denotes Integer Field

Data Card Numbers 3, 6, 9, ...

Data Identifier	Data Format Specification	Data Field Width	
		From Column	To Column
PJ	F6.0	1	6
GJ	F4.1	7	10
FJ	F4.1	11	14
RJ	F6.2	15	20

EXPLANATION OF DATA INPUTS FOR PROGRAM SOJCAL

PT = Radar transmitter power in kW

TAU = Radar pulselength in μsec

GT = Radar transmit gain in dB

GR = Radar receive gain in dB

SIG = Target cross section in m^2

FMHZ = Frequency in MHz

LA = Antenna ohmic loss in dB

LR = Receiving line loss in dB

LT = Radar transmit line loss in dB

LP = Antenna pattern scan loss in dB (1.6 dB for simple azimuth-scanning radar and 3.2 dB for a simultaneously azimuth- and elevation-scanning radar)

LX = Radar miscellaneous loss in dB (includes collapsing loss, signal processing loss, array fill time loss, beam squint loss, polarization-rotation loss, and rain absorption loss)

CB = Bandwidth factor in dB

NP = Number of pulses (or pulse groups)

PD = Probability of detection

FA = False alarm exponent (the positive value of the false alarm probability exponent)

KASE = Swerling fluctuation case (if numbers 0, 1, 2, 3, or 4 are entered, the corresponding fluctuation case will be calculated. If 5 is used, all 5 cases will be calculated.)

ELEV = Target elevation angle in degrees (the jammer is assumed to be at 0-degrees elevation relative to the radar)

NOISE = Galactic noise code (-1 = minimum, 0 = average, +1 = maximum)

PJ = Jammer power in W/MHz

GJ = Jammer antenna gain in dB (if total effective radiated power, ERP, in W/MHz is known, use that ERP for PJ and 0 dB for GJ)

FJ = Jammer pattern-propagation factor in dB (This factor accounts for propagation effects and for the pattern factor of the radar receiving antenna in the jammer direction. For example, if the jamming signal is being received in the peak of a -30 dB sidelobe [or if the average sidelobe level is -30 dB in the direction of the jammer], FJ will be entered as a positive 30.)

RF = Range to standoff jammer in n.mi.

NOTE: The pattern-propagation factor for the radar tramsmitter-to-target and target-to-receiver paths are both assumed = 1.

APPENDIX N

Input Data Format for Program SSJCAL
(June 1977)
(* Denotes Integer Field)

Data Card Numbers 1, 3, 5, ... - Radar Names or Description
Use all 80 columns of card if necessary

Data Card Numbers 2, 4, 6, ...

Data Identifier	Data Format Specification	Data Field Width From Column	To Column
PT	F6.0	1	6
TAU	F6.3	7	12
GT	F4.1	13	16
SIG	F6.2	17	22
FMHZ	F6.0	23	28
PJ	F6.0	29	34
GJ	F4.1	35	38
LT	F4.1	39	42
LP	F4.1	43	46
LX	F4.1	47	50
NP	I5	51	55
PD	F4.3	56	59
FA	F4.1	60	63
KASE	I1	64*	--
ELEV	F4.0	65	68

EXPLANATION OF DATA INPUTS FOR PROGRAM SSJCAL

PT = Radar transmitter power in kW

TAU = Radar pulselength in μsec

GT = Radar transmit gain in dB

SIG = Target cross section in m^2

FMHZ = Frequency in MHz

PJ = Jammer power in W/MHz

GJ = Jammer antenna gain in dB (If total effective radiated power, ERP, in W/MHz is known, use that ERP for PJ and 0 dB for GJ.)

LT = Radar transmit line loss in dB

LP = Antenna pattern scan loss in dB (≈ 1.6 dB for simple azimuth-scanning radar and ≈ 3.2 dB for simultaneously azimuth- and elevation-scanning radar)

LX = Radar miscellaneous loss in dB (includes collapsing loss, signal processing loss, array fill time loss, beam squint loss, polarization-rotation loss, rain absorption loss, and the bandwidth facstor (C_B) which is the loss resulting from a mismatch between the pulse characteristics and the receiver filter transfer characteristic.)

NP = Number of pulses (or pulse groups)

PD = Probability of detection

FA = False alarm exponent (the positive value of the false alarm probability exponent)

KASE = Swerling fluctuation case (If the numbers 0, 1, 2, 3, or 4 are entered, the corresponding fluctuation case will be calculated. If 5 is used, all 5 cases will be calculated.)

ELEV = Target elevation angle in degrees (The jammer is assumed to be at 0-degrees elevation relative to the radar.)

NOTE: The pattern-propagation factor for the radar transmitter-to-target and target-to-receiver paths are both assumed = 1. Also, "average" solar and galactic noise levels are assumed.